FAQs FREQUENTLY ASKED SHORT ANSWER QUESTIONS

With Answers/Hints

Q. 1.01. Rest and motion are relative terms. Explain. (*H.P.S.S.C.E. 2009*)

Ans. Absolute rest and absolute motion have got no meaning as such. For example, two persons sitting in a moving bus are at rest w.r.t. each other but are in motion w.r.t. a person standing on the road side. Further, trees, buildings, etc on the surface of the earth appear to be at rest. In fact, they are in motion as the earth revolves around the sun. Thus, there is no object which can be considered to be at absolute rest. Hence, rest and motion are relative terms.

Q. 1.02. Given below are some examples of motion. State in each case, if the motion is one, two or three dimensional : (*a*) a kite flying on a windy day (*b*) a speeding car on a long straight highway (*c*) an insect crawling on a globe (*d*) a carrom coin rebounding from the side of the board (*e*) a planet revolving around its star.

Ans. (*a*) Three dimensional. **(*b*)** One dimensional.

(*c*) Three dimensional. **(*d*)** Two dimensional.

(*e*) Two dimensional.

Q. 1.03. State in the following cases, whether the motion is one, two or three dimensional : (*i*) An airplane flying in the sky. (*ii*) A train moving along a long and straight track. (*iii*) Earth revolving around the sun.

Ans. (*i*) Motion of an airplane in the sky is ***three dimensional.*** It is because, it may be changing its direction and it may also be losing or gaining the height during its flight.

(*ii*) The motion of the train along a straight track is ***one dimensional.***

(*iii*) The motion of earth around the sun is a ***two dimensional.*** It is because, the plane of the orbit always remains fixed.

Q. 1.04. When can an object in motion be considered as a point object ? Explain in brief.

Ans. Refer to section 1.03.

Q. 1.05. What are the characteristics of displacement ? (*H.P.S.S.C.E. 2009*)

Ans. Following are the main characteristics of displacement :

1. *The displacement has units of length.*

2. *The displacement of an object in a given time interval can be positive, zero or negative.*

3. *The actual distance travelled by an object in a given time interval is either equal to or greater than the magnitude of the displacement.*

Thus, *the displacement of an object between two points tells the shortest distance between these two points.*

4. *The displacement of an object between two points does not tell exactly how the object actually moved between those two points.*

Q. 1.06. Distinguish between distance and displacement. (*H.P.S.S.C.E. 2010 S, 2009 S, 2006 , 2004*)

Ans. Following are the points of difference between the displacement and the distance :

1. *The displacement is a vector quantity, whereas the distance covered is a scalar quantity*

2. *The displacement of an object in a given time interval can be positive, zero or negative, whereas the distance covered is always positive.*

3. *The actual distance travelled by an object in a given time interval is either equal to or greater than the magnitude of the displacement.*

4. *The displacement of an object between two points does not tell exactly how the object actually moved between those two points.*

Q. 1.07. Is magnitude of the displacement of an object and the total distance covered by it in certain time interval same ? Explain.

Ans. No. For details, refer to SAQ 1.05.

Q. 1.08. What are the characteristics of uniform motion ? (*H.P.S.S.C.E. 2009*)

Ans. Following are the main characteristics of uniform motion :

1. Generally, the displacement may or may not be equal to the actual distance covered by an object. However, *when the uniform motion takes place along a straight line in a given direction, the magnitude of the displacement is equal to the actual distance covered by the object.*

2. *For an object to be in uniform motion, no cause or effort i.e. no force is required.*

3. *Since the velocity during uniform motion is same at each point of the path or at each instant, the average and instantaneous velocities in a uniform motion are always equal.*

4. *The velocity-time graph for an object having uniform velocity is a straight line parallel to time-axis.*

Q. 1.09. Distinguish between speed and velocity. (*H.P.S.S.C.E. 2009 S*)

Ans. Following are the points of difference between the speed and the velocity :

1. *Speed is a scalar quantity, whereas the velocity is a vector quantity*

2. *The speed of an object in a particular direction is called velocity of the object.*

3. *Whereas the velocity of an object can be positive, zero* or *negative, the speed of an object can only be positive or zero.*

4. *The speed of an object gives only quantitative knowledge of 'how fast the object is moving'. It tells nothing about the direction of motion of the object. On the other hand, the velocity tells both about how fast the object is moving and its direction of motion.*

Q. 1.10. Sketch the velocity-time graph of unjform motion. What does it represent ? (*H.P.S.S.C.E. 2009 S*)

Ans. For velocity-time graph, refer to Fig 1.07 (*a*).

The area between the velocity-time graph of an object and time-axis is numerically equal to displacement covered by it.

Q. 1.11. A car travels half the distance with constant velocity 30 km h^{-1} and another half with a constant velocity of 40 km h^{-1}. What is the average velocity of the car ?

Ans. Let S be the total distance covered by the car ; and t_1 and t_2 be the time taken by the car to cover first half and second half respectively. Then, total time taken,

$$t = t_1 + t_2 = \frac{S/2}{30} + \frac{S/2}{40} = \frac{S}{60} + \frac{S}{80} = \frac{7S}{240} \text{ h}$$

$$\therefore \quad v_{av} = \frac{S}{t} = \frac{S}{7S/240} = \frac{240}{7} = \mathbf{34{\cdot}3 \text{ km h}^{-1}}$$

Q. 1.12. A car covers a distance S_1 with constant velocity v_1 and another distance S_2 with a constant velocity v_2. What is the average velocity of the car ?

Ans. Let t_1 and t_2 be the time taken by the car to cover the distances S_1 and S_2 respectively. Then, total time taken,

$$t = t_1 + t_2 = \frac{S_1}{v_1} + \frac{S_2}{v_2} = \frac{S_1 v_2 + S_2 v_1}{v_1 v_2}$$

Total distance covered = $S_1 + S_2$

$$\therefore \quad v_{av} = \frac{S_1 + S_2}{t_1 + t_2} = \frac{S_1 + S_2}{(S_1 v_2 + S_2 v_1)/v_1 v_2}$$

$$= \frac{(S_1 + S_2) v_1 v_2}{(S_1 v_2 + S_2 v_1)}$$

Q. 1.13. An object is in uniform motion along a straight line. What will be position-time graph for the motion of the object, if (*a*) x_0 = +ve, v = –ve, (*b*) x_0 = –ve, v = + ve and (*c*) both x_0 and v are negative ? The letters x_0 and v represent position of the object at time $t = 0$ and uniform velocity of the object respectively.

Ans. The position of the object at any time t is given by

$$x = x_0 + v\,t$$

(*a*) *When x_0 = +ve and v = –ve* : The position–time graph will be as shown in Fig. 1.30 (*a*).

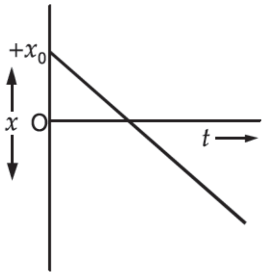

Fig. 1.30 (*a*)

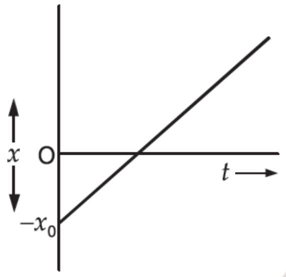

Fig. 1.30 (*b*)

(*b*) *When x_0 = –ve and v = +ve* : The position-time graph will be as shown in Fig. 1.30 (*b*).

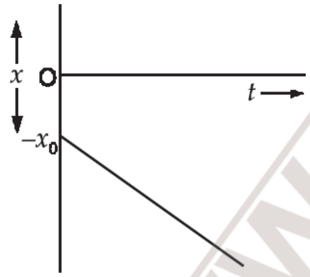

Fig. 1.31 (*c*)

(*c*) *When both x_0 and v are negative* : The position-time graph will be as shown in Fig. 1.30 (*c*).

Q. 1.14. A particle in one dimensional motion with positive value of acceleration must be speeding up. Is it true ? Explain.

Ans. The answer depends on the choice of the positive direction of position-axis.

To explain, let us consider the motion of a body falling freely under gravity and the positive direction of position to be a vertical line in downward direction. It follows that when the positive direction of position-axis is along the direction of motion, the body speeds up.

On the other hand, when a body is projected vertically upwards and the positive direction of position-axis is regarded as to be opposite to the direction of motion, the body slows down, instead of speeding up.

Q. 1.15. 'The direction in which an object moves is given by the direction of velocity of the object and not by the direction of acceleration.' Explain the above statement with some suitable example.

Ans. When an object is thrown up, the direction of motion of the object and its velocity are along vertical in upward direction. As it moves up, it is always attracted in downward direction *i.e.* acceleration is along vertical in downward direction. Therefore, the direction of motion of the object is that of the velocity and not that of acceleration.

Q. 1.16. The v -t graphs of two objects make angles of 30° and 60° with the time axis. Find the ratio of their acceleration.

Ans. The slope of the v -t graph of an object is equal to the acceleration of the object. If a_1 and a_2 are accelerations of the two objects, then

$$\frac{a_1}{a_2} = \frac{\text{slope of } v - t \text{ graph of the first object}}{\text{slope of } v - t \text{ graph of the second object}}$$

$$= \frac{\tan 30°}{\tan 60°} = \frac{1/\sqrt{3}}{\sqrt{3}} = \mathbf{\frac{1}{3}}$$

Q. 1.17. An object has uniformly accelerated motion. The object always slows down before the time, when its velocity becomes zero. Prove the above statement graphically, when (*i*) both v and a are positive, (*ii*) u = –ve and a = + ve, (*iii*) u = + ve and a = –ve and (*iv*) both u and a are negative.

Ans. (*i*) *When both u and a are positive* : This case has already been discussed in section 1.14 and graphically shown in Fig. 1.12.

(*ii*) *When u = – ve and a = + ve* : In such a case, the graph between v and t will be as shown in Fig. 1.32 (*a*). At the time corresponding to the point A, the velocity of the object becomes zero. It can be seen that before this time, the velocity is negative but its magnitude decreases with time, till it becomes zero corresponding to the point A.

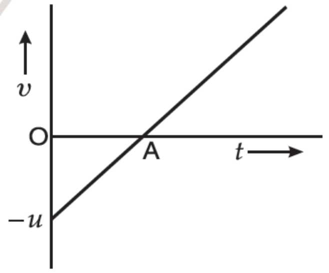

Fig. 1.32 (*a*)

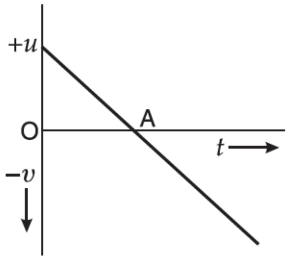

Fig. 1.32 (*b*)

(*iii*) *When u = + ve and a = – ve* : In such a situation, the graph between v and t will be as shown in Fig. 1.32 (*b*). Again, at the time corresponding to the point A, velocity is zero. The velocity decreases before the time corresponding to the point A.

(*iv*) *When both u and a are negative* : Fig. 1.32 (*c*) shows the graph between v and t, when both u and a are negative.

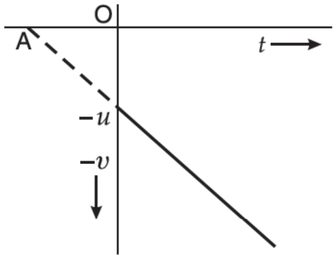

Fig. 1.32 (*c*)

If we produce the graph backwards (shown dotted), it cuts the time-axis in the point A. Before this time, velocity is positive and decreases till the time corresponding to the point A.

Q. 1.18. An object has uniformly accelerated motion. The object always speeds up after the time, when its velocity becomes zero. Prove that the above statement holds, when (*i*) both *u* and *a* are +ve, (*ii*) *u* = + ve, *a* = –ve, (*iii*) *u* = –ve, *a* = + ve and (*iv*) both *u* and *a* are negative.

Ans. Proceed as in SAQ 1.17.

Q. 1.19. Which of the two-velocity or acceleration decides the direction of motion of a body ? Explain, with the help of an example.

Ans. It is the velocity (not acceleration), which decides the direction of motion of a body.

For details, refer to SAQ 1.15.

Q. 1.20. Can a body be at rest as well as in motion at the same time? Explain. (*H.P.S.S.C.E. 2010 S, 2006*)

Ans. Rest and motion are relative terms. A body at rest w.r.t. another body may be in motion w.r.t. some other body. For example, an electric pole is at rest w.r.t. a tree on the surface of the earth. But the same electric pole is in motion w.r.t. an observer in a running train.

Q. 1.21. Draw the position-time graphs for uniform motion of two objects initially occupying different positions, but having zero relative velocity. (*H.P.S.S.C.E. 2010 S*)

Ans. Refer to Fig 1.16.

Q. 1.22. Two objects 1 and 2 are moving along a straight line with velocities v_1 and v_2. How will you find the relative velocity of object 1 w.r.t. 2 ?

Ans. Refer to section 1.13.

Q. 1.23. A car travelling with a speed of 90 km h^{-1} on a straight road is ahead of a scooter travelling with a speed of 60 km h^{-1}. How would the relative velocity be altered, if scooter is ahead of the car ?

Ans. Let v_C and v_S be the velocities of the car and the scooter respectively.

Here, $v_C = 90$ km h^{-1} and $v_S = 60$ km h^{-1}

The relative velocity of the car w.r.t. the scooter,

$$v_{CS} = v_C - v_S$$

***When the car is ahead of the scooter*:**

$v_{CS} = 90 - 60 =$ **30 km h^{-1} (away from the scooter)**

***When the scooter is ahead of the car*:**

$v_{CS} = 90 - 60 =$ **30 km h^{-1} (towards the scooter)**

Q. 1.24. If the distance covered by a moving object varies directly as the time, what conclusions could you draw about the motion and the forces ?

Ans. Here, $x \propto t$

or $x = k\,t$,

where *k* is constant of proportionality.

Now, $$v = \frac{dx}{dt} = \frac{d}{dt}(k\,t) = k$$

Therefore, the body must be moving with constant speed. It implies that there is no net force acting on the body in the direction of its motion.

Q. 1.25. For a particle in one dimensional motion, the instantaneous speed is always equal to the magnitude of instantaneous velocity. Why ?

Ans. In an accelerated motion, the velocity of an object always keeps on changing. Therefore, one has to measure the instantaneous velocity. However, when accelerated motion takes place along a straight line, the velocity of the body changes only due to change in magnitude of velocity. Therefore, the instantaneous speed is always equal to the magnitude of instantaneous velocity of the particle in one dimensional motion.

HOTS HIGHER ORDER THINKING SKILLS

abc — **For ambitious, brilliant & curious Students**

Q. 1.01. Is the time variation of position as shown in Fig. 1.33 observed in nature ? (*I.I.T. 1979*)

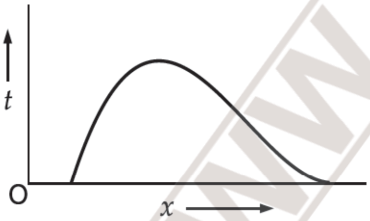

Fig. 1.33

Ans. Fig. 1.01 indicates that as the position of the object changes, initially the time increases, but then starts decreasing.

Since it is not possible, the time variation of position as shown in Fig. 1.01 cannot be observed in nature.

Q. 1.02. Plot the speed-time graph of a car travelling at a uniform speed of 80 km h^{-1}. On the same graph, plot the speed-time graph for a second car starting from rest and uniformly accelerating to a maximum speed of 80 km h^{-1}.

(*a*) What relationship do you find between the distances covered by the two cars during the time in which the second car is accelerating ?

(*b*) Would this relationship hold, if you chose a different acceleration for the second car ? (*Physics Olympiad 1992*)

Ans. For the first car moving with a uniform speed of 80 km h^{-1}, the speed-time graph will be AB *i.e.* a line parallel to time-axis [Fig. 1.34].

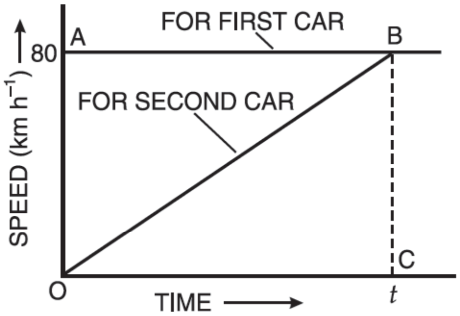

Fig. 1.34

Suppose that the second car possesses a uniform acceleration *a* and starting from rest, accelerates to the speed of 80 km h^{-1}. Since acceleration of the second car is uniform, its speed-time graph will be a straight line, having slope equal to *a*. If OB represents the speed-time graph of the second car, then it follows that the second car will accelerate to the speed of 80 km h^{-1} in a time OC = *t*.

(*a*) The distance covered by the each car is equal to the area under their respective speed-time graphs. Therefore,

distance covered by the first car

= area of rectangle OABC

and distance covered by the second car

= area of triangle OBC

As area of the rectangle OABC is twice the area of the